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Coagulation is an important mechanism in the growth of interstellar and interplanetary dust particles. In astrophysics, the coagulation process is usually treated very crudely. Sticking coefficients are assumed to be either zero or unity depending on whether the particle collision occur at energies greater or less than the attractive van der Waal's potential between the particles.

We have theoretically analysed the microphysics of the coagulation process as a function of the physical properties of the coagulating grains, i.e., their size, relative velocities, temperature, elastic properties, and the van der Waal interaction. Upon collision, the two spheres elastically deform at the contact point forming a contact circle (c.f. Fig. 1). Part of the kinetic (E_K) and the binding energy (E_b) is used for this elastic deformation (elastic energy E_e). This energy is available again for springing the spheres apart (c.f. Fig. 2). The remainder of the collision energy $(E_K + E_b)$ is transformed into compressional waves that travel back and forth in the colliding particles. Part of this wave energy (fraction f) may be dissipated by phonon interaction or internal scattering during the collision and thus sticking will occur if the dissipated fraction of the wave energy is greater than the initial kinetic energy of the colliding particles.

Numerical calculations of collisions between linear chains provide the wave energy in individual particles and the spectrum of the mechanical vibrations set up in colliding particles. Sticking probabilities are then calculated using simple estimates for elastic deformation energies and for the attenuation of the wave energy due to absorption and scattering processes.
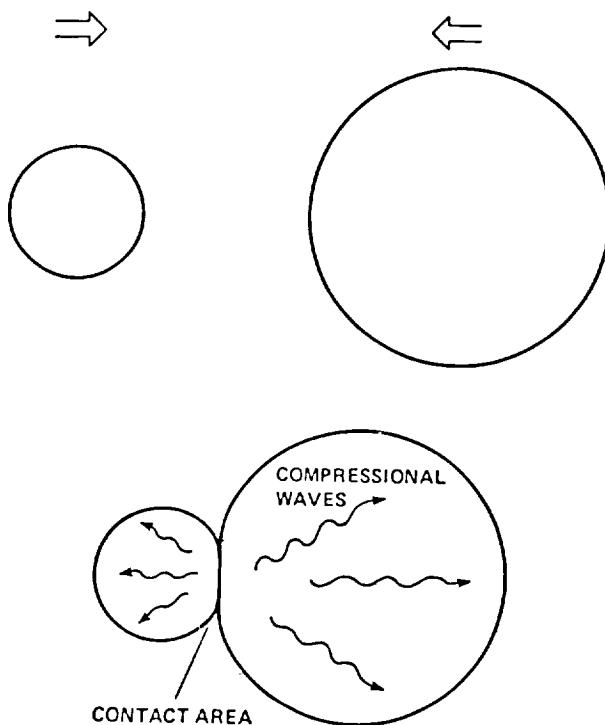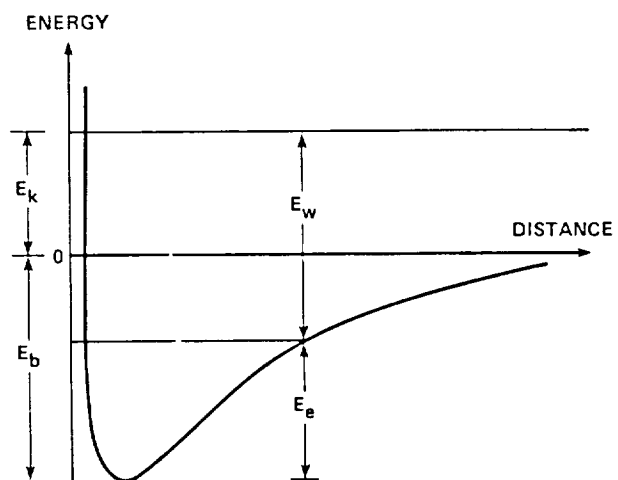

Fig. 1

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Fig. 2